CN513 Navigation Systems Integration III - Integrity Extensions
September 16, 2008, 8:30 am-12:00 pm, CEU: 3.0, prior to ION GNSS 2008
Marriott Savannah Riverfront, Savannah, GA

Instructor: Dr. James L. Farrell, VIGIL Inc.

Prerequisite: Vectors and matrices up to *6x6*; Course CN413 GNSS Integrity or equivalent.

Intended Audience: Technical staff members who wish to supplement classical integrity methods (CN-413) with extension of techniques in several directions: inertial integration, carrier phase, augmentation to include measurement offset, multiple biases, rigorous replacement of vector parity by scalar parity, differencing (accounting for correlations), and availability enhancement via covariance matrices carried to the limit: single-SV RAIM.

Notes Provided: Slides presented will be professionally spiral bound, with clear plastic cover. (See Part IV for 2007 book purchase subsidy).

Reference List: To augment material presented herein, references to be cited were chosen to provide thorough coverage from a manageable (compact) set of sources.

Course Overview: After basic review, extensions are made applicable to both stand-alone and inertial integration, optionally using carrier phase sequential differences. Enhancements noted above are shown to leave navigation solutions unaffected while adding the information intended.

Course Content: The main topics to be covered by this course are:

- Background and review
  - Standard RAIM test
    - issues, considerations, terminology
    - five satellites for fault detection
    - six satellites for fault isolation / exclusion
  - various alternate methods and criteria
  - parity and some subtleties
- Extensions
  - augmentation by individual measurement errors with no change in nav solutions
  - modifications to enable isolation / exclusion with ***scalar*** parity
  - modified formulations to account for correlations with differencing
  - explanation of statistical advantage
- Application to individual measurements (***no geometry requirement*** to achieve validity)
  - usage for carrier phases or pseudoranges or both concurrently
  - rigorously established conformance to Kalman update weighting
  - rigorously established conformance to parity with matrix decomposition
  - straightforward mechanization
    - matrix decomposition in derivation only, not implementation
- Discussion of successful performance in flight
  - fortuitous occurrences (switching and low-elevation satellite)

Course Outcomes: Material presented in this course will enable designers to automate data editing decisions applied separately to each GNSS observation, both carrier phase and pseudorange, before acceptance into navigation data to be processed. Tests can be based on thresholds set according to quantifiable probabilities (missed-detection, alarm), with minimum-detectable bias values ascertained. Successful flight-validated methods are presented in form allowing ease of programming. All valid observations are fully exploited, while data rejection is rare but ***critical*** when needed).